

# Incorporating Complexity in Computing Camps for High School Students – A Report on the Summer Computing Academy Program at Texas A&M University

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## ABSTRACT

Summer computing camps for high school students are rapidly becoming a staple at High Performance Computing (HPC) centers and Computer Science departments around the country. Developing complexity in education in these camps remains a challenge. Here, we present a report about the implementation of such a program. The Summer Computing Academy (SCA) at is a weeklong cybertraining<sup>1</sup> program offered to high school students by High Performance Research Computing (HPRC) at Texas A&M University (Texas A&M; TAMU). The Summer Computing Academy effectively uses cloud computing paradigms, artificial intelligence technologies coupled with Raspberry Pi micro-controllers and sensors to demonstrate “computational thinking”. The program is steeped in well-reviewed pedagogy; the refinement of the educational methods based on constant assessment is a critical factor that has contributed to its success. The hands-on exercises

included in the program have received rave reviews from parents and students alike. The camp program is financially self-sufficient and has successfully broadened participation of underrepresented groups in computing by including diverse groups of students. Modules from the SCA program may be implemented at other institutions with relative ease and promote cybertraining efforts nationwide.

## CCS CONCEPTS

•CS→Computer Science; •Cybertraining→training on using cyberinfrastructure; •HPC→high performance computing

## Keywords

HPC training, summer camps, broadening participation, assessment strategies, best practices. diversity, high school students, computational thinking, artificial intelligence

## 1. INTRODUCTION

The prevalence of computing in everyday life has led to an extensive interest in computing in general and high performance computing in particular. While several efforts cater to the needs of graduate students and professionals, there is a significant drop-off in computing training at the high school level. Despite the Computer Science for All initiative, GenCyber, and CyberPatriot, issues such as insufficient access to computing resources and a lack of proficient trainers have resulted in low computer science adoption at the high school level.[1] Indeed, a recent report on the state of K-12 CS curricula in Texas, entitled “Building the Texas Computer Science Pipeline” discussed

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the effects of the CS Advanced Placement exam and the state educational guidelines for CS course [2]. The report found significant deficiencies in CS education and made a series of recommendations to prepare students for future careers in computer science (CS) related fields. Recommendations included developing parent demand for CS courses, and the advanced placement CS course, by including additional engaging, project-based courses. Finally, the report emphasized the need to inform students, teachers, and administrators to careers in CS by connecting them to CS experts and practitioners. In addition, the prevalent threats to personal information, prevalence of cyber-bullying, the increasing need for confidentiality also make it essential that students learn aspects of the internet, digital citizenship, and cybersecurity at an early age.

The availability of inexpensive devices like the Raspberry Pi significantly lower the entry price point for computing-based education. Use of accessible physical assets, such as cloud computing resources, easy availability of artificial intelligence technologies, and Raspberry Pi clusters coupled with robotics and visualization technologies give educators opportunities to engage learners in complex or problematic scenarios. In this paper, we report on advancements made by the TAMU HPRC Summer Computing Academy program. This paper is presented with a view to help HPC units and departments of Computer Science and Engineering that are either currently hosting similar programs or are interested in developing similar programs. This paper is organized into the following sections. We first describe the SCA program, followed by best practices that have been adopted in the Summer Computing Academy model. We next describe our recruitment strategies and selection criteria for participants followed by our cybertraining model. The following sections provide an overview of how to adopt emerging technologies and a description of our assessment model. The paper next describes legal and administrative issues encountered while hosting such efforts and concludes with a discussion of the sustainability of the effort.

## 2. HISTORY OF THE SCA

The SCA seeks to enable aspiring computer scientists, developers, and engineers in their pursuit of computing fields by offering weeklong cybertraining programs. The goal of this effort is to help usher the next generation of cyber-practitioners in the country. The SCA introduces high school students to various aspects of computational thinking by employing hands-on exercises and active learning activities using Raspberry Pi microcontrollers and sensors [3-10]. The camps are further designed to introduce high school students to concepts in cyber security and promote safe cyber behavior as well. The program is steeped in well-reviewed pedagogy; the refinement of the educational methods based on constant assessment is a critical factor that has contributed to its success. The camp

format and has received rave reviews from parents and students alike. In its recent evaluation, Campus programs for Minors (CPM) for the Texas A&M System has designated the SCA program as a “Model Camp”. Since its inception in 2017, the SCA has offered an introductory camp that is geared for beginners who have not benefited from an opportunity to learn about computing. Beginning in 2018, the SCA also offered an intermediate camp that is geared toward students who have had some exposure to programming in school and are keen to learn about how computing integrates with STEM disciplines. In 2019, the SCA offered camps in Cybersecurity and Artificial Intelligence that were funded by the GenCyber and Governor’s Summer Merit Program of the Texas Workforce Commission. In 2019, on completion of these camps, high students will be able to demonstrate the use of algorithms and loops to a class and explain fundamental principles of cybersecurity and artificial intelligence. They will be able to write code in Scratch or Python that uses variables within algorithmic thinking and loops. As such, the objectives of the SCA program are to:

- Use research-based methods to develop a high-impact, high-immersion opportunity that introduces students to concepts in computing including software, hardware, networking, cybersecurity and data-management practices.
- Engage students in cybertraining skills using hands-on approaches utilizing high-technology and low-technology avenues.
- Reinforce and develop further knowledge of cyber skill sets through hands-on exercises.
- Introduce concepts of cybersecurity and artificial intelligence
- Retain student interest after the camp by offering access to series of free in-person and online cybertraining-themed short courses and seminars organized by Texas A&M HPRC.

Diversity is a core tenet of the SCA program. The 2017 SCA cohort had an even distribution of male and female participants and included a significant number of students from groups that are traditionally underrepresented in computing. In 2018, a total of 55 high-school students are targeted for participation in this high-immersion program. In 2019, a total of 145 high school students will participate in this program. A significant proportion of these attendees will be females and other underrepresented minorities in computing.

## 3. BEST PRACTICES

Working with minors presents a unique set of administrative and educational challenges. This is particularly challenging while working with often overlooked groups such as Foster and home-schooled children. Planning a schedule that includes presentations, capstone assessments, and evaluations, a process involving

numerous faculty, staff, and classroom instructional materials, while maintaining the legal and administrative requirements of the university is a difficult challenge. Here we present a list of best-practices that were adopted by the SCA program.

### 3.1 Pedagogy

Proficiency in computer science widely differs across students. One goal of the registration form is to identify high-achieving or highly knowledgeable students who might need additional frameworks or scaffolds of instruction to be available. To ensure that the learning outcomes of the SCA program are met, we use the information from the student's registration packets and pre-camp package to ensure that each camp has students who are at a similar level of computing proficiency. In addition to asking students to self-evaluate themselves, in 2019, the SCA requested letters of recommendation from teachers. Owing to sponsor requirements, the SCA also collected transcripts (or year-end report cards) and birth-certificates for the first time.

The conceptual framework implemented for training incorporates elements of active learning, such as exploratory learning via research projects, where mentors provide guidance to help focus mentees activities in productive directions and group discussions in research seminars. Active learning has been shown among high-ability trainees to produce significantly higher levels of metacognitive activity than procedural training, leading to the development of higher adaptive transfer. In addition, the training

provided through the introductory camp incorporates several elements of the experiential learning cycle in which:

- A. Students are introduced to several aspects of cyber security. (New experiences)
- B. Exercises encourage students to integrate and apply previously developed to specific problems. (Critical thinking)
- C. Students must select and apply skills from their repertoire to problems by developing hypotheses and validating them. (Hands-on experimentation)

### 3.2 Advancing Knowledge and Understanding in Computing [3-10]

Computing is a constantly evolving landscape. Disruptive computing technologies result in new threats that appear on extremely short timescales. Therefore, computing education must prepare learners to stay abreast of both current and emerging technologies along with effective responses. To develop desired capabilities, the SCA program focuses on the described attributes:

(a) Defining desired capabilities – Effective CS education begins with iteratively refining desired learning outcomes at the Analyzing, Evaluating, and Creating levels of the Revised Bloom's Taxonomy. The SCA defined learning outcomes will provide the foundation for the next three phases.

(b) Operationalizing learning outcomes – While SCA learning outcomes articulate expectations for learner achievement, we also develop assessment activities to provide opportunities for learners to demonstrate achievement.

(c) Evaluating learner development – Once learners have completed an assessment activity, their learning must be evaluated both formatively and summatively. Consistent and detailed evaluation information is facilitated through development of scoring schemes, also known as rubrics. Explicit descriptions of levels of achievement will help learners understand expectations for their performance as well as help SCA team members provide helpful feedback to the students.

(d) Facilitating learning – With the foundation of learning outcomes, assessment activities, and scoring schemes, the project team can develop learning activities using research-based instructional approaches. An emphasis on cooperative teamwork and active engagement will be the basis of the camp's learning activities

### 3.3 Security and Child Protection Measures

The SCA program is guided by TAMU CPM guidelines. These include providing camp counselors at a ratio of 1 counselor per 12 campers. All counselors and instructors will complete Child Protection training and undergo Background Checks. Campers will be monitored and accompanied by counselors while on campus at all times. There will also be personnel trained in first-aid and CPR. Campers and counselors wear identifiable SCA camp specific T-shirts and badges. These badges include information about the camp's location, emergency camp contact and the student participant's emergency contact. As part of the camp's accreditation process at TAMU, the camp makes accommodations for students with disabilities, and all camp locations are accessible to students with disabilities.

### 3.4 Administrative Best Practices

TAMU staff and faculty form the SCA team are charged with delivery of the camps. In compliance with TAMU Campus Programs for Minors guidelines, there will be a minimum of three instructors present at any time for the twenty-five children. At all times, at least one male and one female camp supervisor will be present. All instructors have previously been K-12 instructors and/or have previously instructed K-12 summer camps. Preparation for the SCA begins three months prior to the event. All faculty

and volunteers meet on a bi-weekly basis to plan the curriculum, schedule, and the materials for the program. Based on program assessments and participant reviews, a significant number of materials were adopted from the 2017 SCA offering. These meetings help all parties review compliance and regulatory issues as well. All SCA teaching material and requisite forms, are posted online and will be available to camp participants a week prior to the camp. Typical days begin at 8:00 AM and end at 4:30 PM. Each day will end with a de-brief so that instructors may reflect about the day's activities and coordinate events for the next day. The program provides a final session on each day will end with a brief recap. On Friday, the cohort is dismissed at 3:30 PM following an informal reception during which certificates are awarded. Parents and guardians are invited to the reception and get to talk with the instructors.

#### 4. RECRUITMENT AND SELECTION

Student recruitment is a critical aspect of a program's success. In order to effectively recruit youths who have not been exposed to computing but yield high promise, we developed a novel recruitment strategy. Rather than focusing on students working with computer science teachers and computing clubs, we found participants from language clubs, food clubs, dance groups, and online gaming communities. A high degree of academic performance and intrinsic motivation were, however, a must. The diverse participant body at our camp, and long waitlists amply demonstrate the effectiveness of our recruiting program. The SCA program is advertised online and interested attendees fill out an online application, which includes a statement of interest and a letter of recommendation. Outreach efforts are made through existing contacts with a number of Independent School Districts in the Houston, Dallas, Waco, Austin and San Antonio regions. The effectiveness of our recruiting system is best demonstrated by applications coming in from across the Southern seaboard (Florida to California). In 2018, both SCA camps are significantly oversubscribed. We started pre-registering for the 2019 Summer Computing Academy in 2018 and are now on track to offer 145 scholarship positions spread out over 4 camps. For our merit camps, the following criteria are currently used to evaluate applications:

- The participant's academic achievement (Target: high)
- Impact statement describing the student's interest in computing. (Target: high enthusiasm)
- Program participant desired ratio (Target: high)
- Ratio of students belonging to an underrepresented group in computing (Target: high)
- Ratio of male to female participants (Target: balanced)

2019 represents a departure from our merit-based approach. As such, the criteria used to evaluate applications were:

- The participant's academic achievement (Target: adequate)
- Impact statement describing the student's interest in computing. (Target: curious about computing)
- Ratio of students belonging to an underrepresented group in computing (Target: high)
- Ratio of male to female participants (Target: balanced)

Information about the applicant's previous exposure to computing is collected during the camp application process via the application form and mentor's recommendation letters. This information is used to judge the best possible camp for every participant.

The SCA program is particularly successful at addressing challenges in broadening access and adoption of cybersecurity skills to the nation's scientific and engineering workforce by *(a)* Producing course material that utilizes established pedagogical methods such as research project-based learning to prepare a community of students; *(b)* Developing and disseminating online modules for continuing and remote education; *(c)* Leveraging existing collaborations to recruit participants from groups that are traditionally underrepresented in the STEM and computing fields. As a measure of success in this capacity, the 2017 SCA boasted of incredible diversity in terms of socioeconomic classes of camp participants, female: male ratio of participants (11:11) and instructors (5:5) and richness of computing experience. These students self-identified as being Hispanic, African American, Asian, Mixed-race and/or Caucasian.

#### 5. CYBERTRAINING FOR FUTURE STEM PROFESSIONALS

The SCA program is designed on the principles of engagement, training, retention, and sustainability to promote the CI professional career path. The SCA is unique as it adopts a novel instructional approach that was developed to provide a holistic view of the computing landscape in STEM rather than merely impart programming skills. With a view toward broadening the learning and understanding of students through further diversification of learning approaches, we designed the educational process using the backward design approach. We first identified the learning objectives and competencies that participants were expected to learn and built each exercise around them. Modules are developed using a philosophy of "deliberate practice", i.e. practice with essential feedback. We employ a hybrid method of instruction that relied on the principles of guided discovery via observation and hands-on based laboratory-type learning. The students will develop new skill-sets through this high-impact learning community experience. Students will be taught a grounds-up approach towards cybersecurity on Raspberry Pi computers using sensors and LED devices.

During in-class lectures, students are introduced to the First Principles via lectures, programming, and games. An emphasis is placed on data hygiene, safe cyber behavior, protection from cyber pornography and cyber bullying; and perhaps most importantly cyber ethics. The idea that cyber activities could have deleterious consequences are reinforced. Since students are likely to gravitate towards exercises that are attached to something that they can see or touch, computing exercises are based on sensors that they were able to see, hear, and otherwise interact with. We encourage students to debug by introducing features in activities that would cause them to fail. Over the course of the program, these exercises introduced students to various aspects of computing while simultaneously encouraging computational thought. To encourage student participation while ensuring that we successfully covered the material, we include structured and unstructured components to each session. Instruction sessions begin with a three to five-minute topic introduction that employs real-world issues to begin discussions. Connections between the real-world issue and the class topic are pointed out during this time. Students perform activities with brief pauses to answer questions on the topic. After the first half of the session, students will be allowed to work on activities at their own pace, allowing students with advanced skills to move to more challenging exercises. The instructor and assistants are available to help students as they worked through these exercises. To foster networking and build a student community, participants who successfully completed an exercise are encouraged to help others. Students are taught to use the Github repository for code. The instructor will facilitate progress but do not lecture or direct progress. Finally, the instructor, emphasizing the relationship between the key concepts and the relevant real-world examples, would lead a brief recap discussion that was followed by a capstone exercise. To ensure that students receive a different view of topics, review sessions will be taught by a different instructor. Moreover, the review sessions also integrate concepts covered in previous sessions. Each session is guided by how the students participated in previous review sessions. Concepts covered in the classroom will be reinforced by demonstrations at facilities that underscore the importance of the taught material in real-world scenarios.

In-class exercises and instruction are backed up by visits to on-campus facilities such as the “Teague Super Computing Data Center” that houses the Ada and Terra compute clusters and the state-of-the-art “Engineering and Innovation Center” fabrication laboratory. These site visits to facilities allow students to experience cybersecurity principles applied to various aspects of day-to-day computing.

## 6. OPTING EMERGING TECHNOLOGIES

The rapidly changing nature of the cybersecurity landscape underscores the need for young adults to be prepared to identify and mitigate new threats in their daily lives. The SCA program offers a blend of cybersecurity and visualization technologies to students in an innovative learning environment. Modeling and visualization are participatory technologies that provide the means to achieve engagement while legitimizing the role of computing in scientific discovery and research. Participating students will use our newly developed NSF-funded CiSE-ProS learning modules and virtual reality interfaces. Students will learn about multiple aspects of cybersecurity in both of our camps. Of particular note are the exercises on the last day of the Introductory SCA camp. Students play the well-reviewed “capture the flag” exercise on a Raspberry Pi equipped with a LED display board, called a pi-hat. In this exercise, each student is assigned a specific color that is displayed on their pi-hat. Students can then choose to “defend” their Raspberry Pi and ensure that the pi-hat keeps the same color. Else, they could “capture” someone else’s Pi by changing the captured Pi hat’s colors to show their color. This exercise allows students to experiment with defensive strategies, probe others for vulnerabilities in their defensive structure and puts all that they learned during the camp to test. Students can form groups to capture a pi and change the color on the raspberry pi-hat display to display their color. Previously, students have worked as a group, by running a password guessing program in parallel on each other’s machines, while others have employed similar maneuvers to constantly change their network settings. This exercise is much enjoyed; it is followed by a reminder about ethical behavior and a how to be a good cyber citizen. In 2018, we we particularly excited about introducing students to exercises using AI, cryptography and the TAMU virtual reality simulator that emphasizes cybersecurity principles from a hardware perspective. Students had the opportunity to freely explore a data center in a virtual reality environment with haptic controls. Students are free to “walk” in the VR data center and understand the various aspects of data center security as well. The exercise directs to replace a compromised node for a new node. This exercise was followed by a programmatic evaluation survey that showed that students were comfortable with the use of VR technologies, understood key concepts of cybersecurity and appreciated the physical interactions in the data center room. A prototype of the CiSE-ProS VR simulator was demonstrated at the TAMU HPRC booth SuperComputing 17 Conference in Denver, CO, and again at the TAMU HPRC booth SuperComputing 18 Conference in Dallas, TX.

## 7. ASSESSMENTS AND EVALUATIONS

The SCA has received highly positive reviews from students and parents alike. Post-camp surveys and assessments reported 100% improved attitudes to computing and STEM and computing. After attending the SCA, 30% of female (Hispanic and African American) participants said that they were more likely to major in Computer Sciences! A number of students from the 2017 SCA have gone on to apply to the Computer Science program at TAMU and STEM programs at other universities. As further evidence of success, a significant number of students from the 2017 SCA cohort who have yet to graduate from high school will be attending the 2018 SCA Intermediate camp.

Prior to engagement with the academy, potential participants complete an application which is designed to acquire a sense of each applicant's predilection towards computer science topics. The application along with accompanying letters of reference from teachers help guide the staff's understanding of each participant's interest and experience with microcomputers and programming. The following questions are examples of the types of questions used for the pre-camp evaluation.

- (i) How familiar are you with the Raspberry Pi?
- (ii) How familiar are you with Python programming?
- (iii) Rate your prior level of coding experience.
- (iv) Please describe how this program will help achieve your personal and academic goals.

After the conclusion of the camp, participants are given the opportunity to evaluate their experience. This evaluation is conducted in the form of several questions which aim to convey the participant's expectations as well as whether or not the computing academy met said expectations. The following questions are a select few of the more than twenty questions used in the evaluation.

- (i) Are you planning to pursue a degree in a STEM field? If you answered yes, did attending the camp have any influence on that decision?
- (ii) Did you use any of the skills gained from the computing academy (for example started programming as a hobby, experimenting with your Raspberry Pi, used it in school projects etc.?)
- (iii) Did you take any computer related courses in school before the summer camp and did you take any extra computer related courses after attending the camp and if so, did attending the camp have any influence on it?
- (iv) Did you participate in any other STEM-related extracurriculars? (e.g other camps) Are you still using your Raspberry Pi?

Throughout this experience, we have found that teaching students new computing concepts, such as navigating a Linux environment, using a command line, and writing code, is more productive when done through an interactive

format rather than using a lecture format that is interspersed with a few activities. With an interactive format, students are more motivated to follow along with the instructor and other students by participating in the activities. This promotes the practice of a new concept or technique and allows for greater retention of the new information by the student. Capstone exercises found that lectures which did not follow this interactive format were much less successful than their interactive counterparts. Non-interactive lectures often left many students behind and afraid to ask questions. This led to students becoming bored and inattentive, causing them to retain little to no information from the lecture. Those lectures that were interactive promoted student engagement with the instructor and the rest of the class. The students were more attentive and willing to ask questions when they did not understand a topic. These lectures also provided ample opportunity for the students to practice the topics they were learning which promoted an understanding of the application of their newfound knowledge and greater retention thereof. While most students were familiar with Google Drive, Git/GitHub adoption in workflows remained a challenge. In a surprise to us, participants were successfully able to perform basic operations using Gedit in a matter of minutes. Students (and parents) were more likely to participate in a distributed (online) training session after an in-person activity as compared to those without the face to face interaction.

In future iterations, we hope to assess student skills and competencies both pre-and post-camp using a SLAG type evaluation scheme. Representative samples of students and their parents will be interviewed. Some of the topics will include their experience in the camp, motivation to pursue careers in STEM and cybersecurity and ways to refine the offerings. These assessments will be used to inform future iterations of camps. The administration of these instruments is designed to be anonymous and the assessment will demonstrate the knowledge acquisition from the camp. Follow up will be through surveys such as the popular STEM Semantics Survey and STEM Interest Survey, which will be administered at the beginning and end of the camps and again 6 months later. Open-ended questions allow campers to explain their perceptions of how the camp experience impacted their interest in cybersecurity and STEM-related careers. In 2019, the SCA started a post-camp survey that was common to the GenCyber program.

## 8. LEGAL AND ADMINISTRATIVE ISSUES

The requirements for hosting the SCA stem from a shared commitment to provide a safe environment and meaningful experience for participants that not only meet the minimum legal requirements but also reflect the Texas A&M University's core values of Excellence, Integrity, Leadership, Loyalty, Respect, and Selfless Service. To

make sure these requirements are met, SCA staff works together with the Campus Program for Minors and the Internal Review Board at Texas A&M University [11]. In 2019, Texas A&M's IRB exempted the SCA. The requirements for compliance are outlined by the Texas A&M University Rule for Campus Programs for Minors [12]. These requirements can be classified into two categories; Program logistics and Program Compliance. It is important to have supervision ratios in place that help ensure the safety of the participants and the quality of the SCA. The American Camps Association [13] (ACA) recommends having at least one qualified staff member for every 12 SCA participants. The SCA typically maintains at least one qualified staff member for every 10 participants and ensures that there is always at least one female and one male staff member present at all times. Lunch during the SCA is provided by the nearest campus dining facility to limit exposure to the Texas summer heat and to limit traveling times. Furthermore, campus dining facilities meet the requirements of the University catering policy, CPM requirements, and ADA standards. The SCA will check with participants before the beginning of the program to determine whether there will be any specific dietary needs, restrictions, or requests.

**Table 2: Information, Consent, and Authorization forms required by Campus Programs for Minors at TAMU.**

Liability Waiver	informs participants and their guardians about the potential risks associated with the camp as well as waives Texas A&M University of liability in the event of an accident
Media Release	informs participants about their release of their likeness and image for use in media to promote future computing academies
Code of Conduct	establishes an expectation of behavior to be adhered to by the participants
Github Account Consent	informs participants of their use of Github, obtains consent from their guardians to allow their participant to create a Github account for use with version control exercises
Participant Pick-up Authorization	informs guardians about pick-up procedure and establishes rules for authorizing participant's daily departure from the academy
Medication Disbursement	obtains information regarding the disbursement of medication to students
Online Gaming	Permission to play online games

Research information	Informs parents that the students may be asked to participate in a research program
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Every staff member and volunteer is required to pass a criminal background check performed by Texas A&M Human Services. In addition, to comply with the Texas Education Code, every staff member must successfully complete a comprehensive child protection training. The Texas A&M University System created an online training course that meets the requirements of the Education Code [14] and has been approved by the Texas Department of State Health Services. SCA also needs to identify a hospital/urgent care facility to refer participants to in the event of an emergency. and SCA will send a letter to the chosen medical facilities letting them know the dates of the program, approximate number of participants, and the policy information for the insurance coverage. the SCA will purchase general liability and accident medical coverage through System Risk Management as required by Texas A&M University System regulations.

Instruction for the Student camp takes place at the state-of-the-art Interdisciplinary Life Sciences Building teaching facility and the state-of-the-art Zachry Engineering Education Complex at Texas A&M University. This training avenue is compliant with ADA standards and ensures that we can support students with specific individual requirements. This unique teaching space is designed to accommodate the facilitation of hands-on training and education providing a flexible workspace with a modular group working environment layout. The room is a flexible space that can seat over 300 students. This facility supports not only classroom instruction, but is ideal for supervised hands-on-exercises as well.

## 9. SUSTAINABILITY AND SCALABILITY

Every aspect of the SCA program was designed with sustainability in mind. Student training in computing is a critical area where demand currently outweighs supply. The camp's format was well received by the community and the camps have been oversubscribed since 2017. Owing to the demand from the community, these camps are inherently sustainable. In 2019, we demonstrated this aspect via funding from the GenCyber and Texas Workforce Commission programs. Lenovo, Dell, Google, and MarkIII were corporate sponsors of the event. In addition to need, we have encouraged continuity by adopting camp training materials in our HPRC training sessions and describing these efforts in our proposals. Indeed, knowledge repositories of training materials are made available free-of-charge to future camp providers. These camps also provide opportunities to work with Assistant Professors who are preparing their portfolio for CAREER or YIP awards. Finally, the key elements to sustaining the educational, organizational and cyber aspects of the effort

include plans to seek external funding and commercializing technologies. While the program remains oversubscribed in 2018 as well, it has a fee-based structure. Federal support for these programs would help eliminate fees and help the camps as well.

The proposed project can be scaled to reach a broader audience in the future. In 2018, the SCA extended its offering to include an Intermediate Camp as well. In 2019, we are offering camps with a concentration on Cybersecurity and Artificial Intelligence. We are currently exploring possibilities of organizing an advanced camp in 2020 and teacher training camps as well.

Schools districts in Texas are currently implementing a computing-based curriculum. [2-10] The improvements to the curriculum are part of Texas's education vision that describes the path for teacher student success. Funds budgeted by School Districts for teacher professional development will support these training initiatives as well.

## 10. CONCLUSIONS

Texas A&M University SCA program currently offers two merit-based summer camps designed to promote a hands-on cyberlearning experience for high-school students. The camps 1) enhance participant engagement 2) enhance participant understanding of complex computing concepts using observational experiences, and 3) provide participants with a learning environment that utilizes state of the art technology. In the future, we hope that the camps will follow the spirit of the Stanford Transcription model, where participating students will receive a letter confirming participation, that can accompany their applications to pursue a degree program at TAMU. Despite having participants at different levels of computational proficiency, this novel program maintained a retention rate of 100% during the week. Currently, efforts are underway to deploy scoring schemes and rubrics that were created by the GenCyber program to accompany each assessment activity. Identifying the skills of a registered participant and incorporating them as a class remains a significant challenge for such efforts. Toward this, we will offer a registration quiz for advanced camps to accurately identify the student's proficiency before the start of the program. In future iterations, the SCA program will offer research opportunities to contribute during the product development phase and the design of instructional activities. Finally, a select number of SCA counselors have completed Internal Review Board (IRB) training in order to study and report on student learning outcomes.

All SCA materials are available free-of-charge to the national CI training community at our website [hprc.tamu.edu](http://hprc.tamu.edu). [15-17] Agendas, registrations forms, sample announcements, templates to track participants,

Trello event boards and other such materials will be made available by the authors on request.

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## 12. REFERENCES

- [1] Research on Learning in Formal and Informal Settings, National Science Foundation, URL - [https://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=505359](https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505359)
- [2] Texas Regional Collaboratives, "Building the Texas Computer Science Pipeline Strategic Recommendations for Success | theTRC.org," 2014
- [3] A. Yadav, N. Zhou, C. Mayfield, S. Hambruch, and J. T. Korb, "Introducing computational thinking in education courses," in Proceedings of the 42nd ACM technical symposium on Computer science education, pp. 465–470, ACM, 2011.
- [4] J. J. Lu and G. H. Fletcher, "Thinking about computational thinking," in Proceedings of the 40th ACM Technical Symposium on Computer Science Education, SIGCSE '09, (New York, NY, USA), pp. 260–264, ACM, 2009.
- [5] K. Brennan and M. Resnick, "New frameworks for studying and assessing the development of computational thinking," in Annual American Educational Research Association meeting, (Vancouver, BC, Canada), 2012
- [6] S. Y. Lye and J. H. L. Koh, "Review on teaching and learning of computational thinking through programming: What is next for K-12?," Computers in Human Behavior, vol. 41, pp. 51–61, 2014.
- [7] J. M. Wing, "Computational thinking and thinking about computing," Philosophical transactions of the royal society of London A: mathematical, physical and engineering sciences, vol. 366, no. 1881, pp. 3717–3725, 2008.
- [8] M. Prince, "Does active learning work? a review of the research," Journal of engineering education, vol. 93, no. 3, pp. 223–231, 2004.



- [9] H. Eshach, "Bridging in-school and out-of-school learning: Formal, non-formal, and informal education," *Journal of science education and technology*, vol. 16, no. 2, pp. 171–190, 2007.
- [10] J. Parsons and L. Taylor, "Improving student engagement," *Current issues in education*, vol. 14, no. 1, 2011.
- [11] Campus Program for Minors: <https://cpm.tamu.edu>
- [12] Texas A&M Campus Programs for Minors Rules: <http://rules-saps.tamu.edu/PDFs/24.01.06.M1.pdf>
- [13] American Camp Association: <https://www.acacamps.org/>
- [14] Texas Education Code: <https://statutes.capitol.texas.gov/Docs/ED/htm/ED.51.htm#51.976>
- [15] D. K. Chakravorty, M. Pennings, H. Liu, Z. Wei, D. M. Rodriguez, Levi T. Jordan, D. F. McMullen, N. Ghaffari, and S. D. Le. "Effectively Extending Computational Training Using Informal Means at Larger Institutions," *Journal of Computational Science Education* 2018, 40-47 DOI 10.22369/issn.2153-4136/10/1/7.
- [16] D. K. Chakravorty, M. Pennings, H. Liu, Z. Wei, D. M. Rodriguez, L. T. Jordan, D.F. McMullen, N. Ghaffari, S. D. Le, D. Rodriguez, C. Buchanan, and N. Gober. "Evaluating Active Learning Approaches for Teaching Intermediate Programming at an Early Undergraduate Level," *Journal of Computational Science Education* 2018, 61-66 DOI 10.22369/issn.2153-4136/10/1/10.
- [17] D. K. Chakravorty, D. F. McMullen, N. Gober, J. H. Seo, M. Bruner, and A. Payne. "Using Virtual Reality to Enforce Principles of Cybersecurity," *Journal of Computational Science Education* 2018, 81-87 DOI 10.22369/issn.2153-4136/10/1/13.